# Java Persistence API

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# Goal of This Talk

Learn more about the Java Persistence API

# Agenda

- **Entities**
- **Persistence Units**
- **Persistence Contexts**
- **Entity Manager API**
- **Queries**
- **Object/Relational Mapping**
- **Persistence in Java SE**

# Primary Features

- Simple to use and intuitive to learn
- POJO development model
- Object-oriented - inheritance, polymorphism, etc.
- Standardized metadata for object-relational mapping expressed in annotations, XML or combination of the two
- Entity detachment to other tiers and JVMs
- Java Persistence Query Language uses entity schema for querying across entities in the database
- Java SE persistence model for testing and client apps

# Entities

- Persistent objects
  - **Entities, not entity beans**
  - **Java objects, not “components”**
  - **Serializable, detachable and mergeable**
  - **Indicated by @Entity**
- Persistent state
  - **Defined by persistent fields or properties**
  - **Must minimally include persistent identity**
  - **Entities may also have non-persistent state**

# Entities

- Persistent identity
  - **Uniquely identifies entity in database (primary key)**

**1. Simple field/property**

```
@Id int custId;
```

**2. Single field/property to store an instance of a composite PK class**

```
@EmbeddedId CustPK id;
```

**3. Multiple fields/properties that are all present in a composite PK class (compatible with EJB 2.x)**

```
@IdClass(CustPK.class)
```

# Example

```
@Entity
public class Customer {
   @Id private Long id;
   private String name;

   public Long getId() { return id; }
   private void setId(Long id) { this.id = id; }

   public String getName() { return name; }
   public void setName(String name) { this.name = name; }
}
```

# Persistence Unit

- **Set of entities and related classes that share the same configuration**
- **Convenient packaging and deployment unit**
- **Runtime configuration defined in persistence.xml**
- **Can reference additional classes on classpath or additional jar**
- **One or more O/R mapping files**
- **Scoping boundary for queries and id generators**

# Example

```
<persistence>
  <persistence-unit name="OrderMgmt">
    <provider>com.acme.PersistenceProvider</provider>
    <jta-data-source>jdbc/MyOrderDB</jta-data-source>
    <mapping-file>order-mappings.xml</mapping-file>
    <jar-file>myparts.jar</jar-file>
    <properties>
      <property
        name="com.acme.persistence.logSQL"
        value="ALL"/>
    </properties>
  </persistence-unit>
</persistence>
```

# Persistence Context

- Set of “managed” entity instances at runtime
  - Unique entity instance for any given persistent identity
- Maintained and operated on via EntityManager API
- Normally scoped to a container transaction
- May also be extended to keep entities managed across multiple sequential transactions
  - Stateful session beans
  - Application-managed EntityManagers
- Propagated across EJB components within JTA transactions

# Persistence Context Propagation

```
@Stateless public class Bean1Class implements Bean1 {
  @PersistenceContext EntityManager em1;
  @EJB Bean2 bean2;
  public void bean1Method() {
    em1.persist(new Customer(100));
    bean2.bean2Method();
  }
}
@Stateless public class Bean2Class implements Bean2 {
  @PersistenceContext EntityManager em2;
  public void bean2Method() {
    Customer cust = em2.find(Customer.class, 100);
    cust.setName("");
  }
}
```

# Entity Manager API

- **Used by application to operate on entities**
  - `persist()` – Insert the entity into the database
  - `remove()` – Delete the entity from the database
  - `refresh()` – Reload the entity state from the database
  - `merge()` – Synchronize state of detached entity with the pc
  - `find()` – Execute a simple PK query
  - `createQuery()` – Create dynamic query using EJB QL
  - `createNamedQuery()` – Create a predefined query
  - `createNativeQuery()` – Create SQL query
  - `contains()` – Determine if entity is managed by pc
  - `flush()` – Explicitly synchronize pc to database

# Persist Operation

- Insert a new instance of the entity into the database
- Save the persistent state of the entity and any owned relationship references
- The entity instance becomes “managed” in the pc
- Persist operation optionally cascades to related objects

```
public Customer createCustomer(int id, String name) {
   Customer cust = new Customer(id, name);
   entityManager.persist(cust);
   return cust;
}
```

# Find and Remove Operations

- **Find**
  - **Obtain a managed entity instance with a given persistent identity**
  - **Return null if not found**
- **Remove**
  - **Delete entity with the given persistent identity from the database**
  - **Optionally cascades to related objects**

```
public void removeCustomer(Long custId) {
   Customer cust =
        entityManager.find(Customer.class, custId);
   entityManager.remove(cust);
}
```

# Merge Operation

- State of detached entity gets merged into a managed copy of the detached entity
- Managed entity that is returned has a different Java identity from the detached entity
  - May be an entity instance that was previously in the pc
- Merge operation optionally cascades to related objects

```
public Customer storeUpdatedCustomer(Customer cust) {
   return entityManager.merge(cust);
}
```

# Entity Lifecycle Callbacks

- **Entity Listeners may be defined to receive notification of lifecycle events**
  - `@PrePersist` - when the application calls `persist()`
  - `@PostPersist` - after the SQL `INSERT`
  - `@PreRemove` - when the application calls `remove()`
  - `@PostRemove` - after the SQL `DELETE`
  - `@PreUpdate` - when the container detects that an instance is dirty
  - `@PostUpdate` - after the SQL `UPDATE`
  - `@PostLoad` - after an instance was loaded

# Queries

- EntityManager acts as a factory for Query objects
- Uses Java Persistence Query Language
- Native queries allow native SQL customization
- Can use positional or named parameters
- Can use static queries or dynamic queries
  - Dynamic query string specified at query creation time
  - Static queries are defined at development time as annotations or in XML
- Control over query execution, parameter binding and pagination
- Queries can return entities, non-entities, or projections of entity data

# Dynamic Query

```
public List findAll(String entityName){
   return entityManager.createQuery(
    "select e from " + entityName + " e")
      .getResultList();
}
```

- Return all instances of the given entity type
- Query string composed from entity type

  For example, if "Customer" was passed in then query string would be: "select e from Customer e"

# Static Query

```
@NamedQuery(name="findByCustId",
     query="select o from Order o
            where o.customer.id = :custId
            order by o.createdDate")

public List findOrdersByCustomer(Customer cust) {

  return entityManager.createNamedQuery("findByCustId")

            .setParameter("custId", cust.getId())

             .getResultList();

}
```

- Return orders for a given customer
- Use a named parameter to pass in customer id

# Static Query

```
<entity-mappings>
    …
    <entity class="com.acme.Order">
        <named-query name="findByCustId">
            <query>select o from Order o
                where o.customer.id = :custId
                order by o.createdDate
            </query>
        </named-query>
    </entity>
</entity-mappings>
```

# Query Language Enhancements

- Support for joins
  - ```
    select o from Order o
      left join o.lineItems li
      where li.amount > 100
    ```
- Support for subqueries
  - ```
    select distinct o from Order o
       where exists
          (select li from o.lineItems li
           where li.amount > 100)
    ```
- Support for aggregation
  - ```
    select o.id, sum(li.amount) from Order o
      join o.lineItems li group by o.id
    ```
    ```

# Query Language Enhancements

- Data projections
  - `select o.item.name, o.quantity from Order o where o.quantity > 100`
- Additional functions
  - `trim(), locate(), concat(), substring(), lower(), upper(), length(), abs(), sqrt(), mod(), size()`
- Update and delete operations
  - `update OrderLine ol set ol.fulfilled = 'Y' where ol.order.id = 9876543`
  - `delete from Customer cust where cust.id = 12345`

# Object/Relational Mapping

- Logical and physical mapping views
  - Logical—object model (e.g. @OneToMany, @Id, @Transient)
  - Physical—DB tables and columns (e.g. @Table, @Column)
- Support for basic, serialized objects, LOBs, enums, etc.
- Access to object state using fields or properties
- Single-valued and collection-valued relationship mappings
- Multiple tables, composite relationship keys
- Rules for defaulting of database table and column names
- Specified as annotations or XML

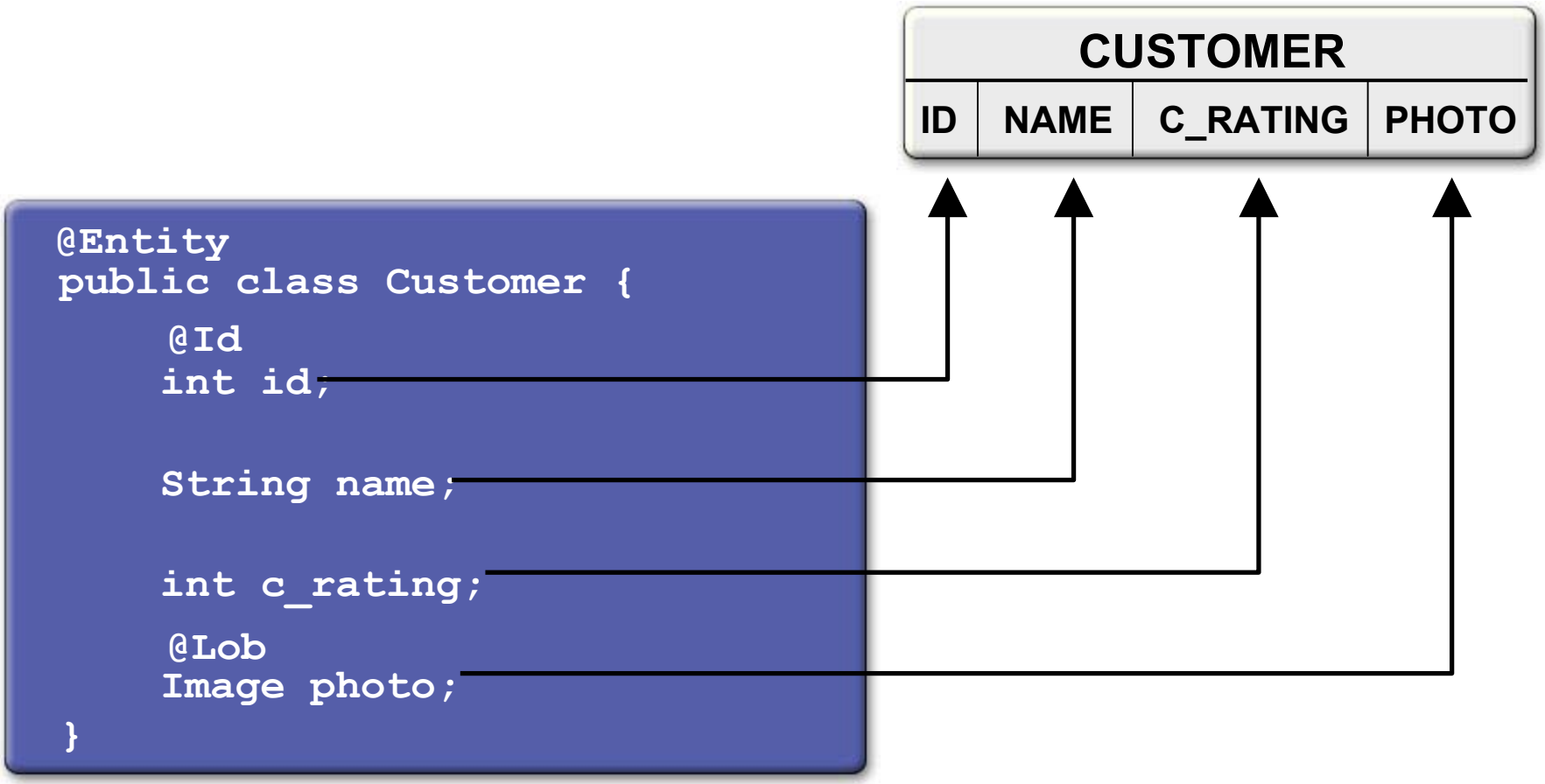
# Object/Relational Mapping

- **Can specify EAGER or LAZY loading of fields or relationships**
  - **Fetch mode LAZY is a hint to the Container to defer loading until the field or property is accessed**
  - **Fetch mode EAGER requires that the field or relationship be loaded eagerly**
- **Cascading of entity operations to related entities**
  - **Can cascade PERSIST, REMOVE, MERGE, REFRESH or ALL**
  - **Setting may be defined per relationship**
  - **Configurable globally in orm.xml for persistence-by-reachability**

# Simple Mappings

- Direct mappings of fields/properties to columns
  - @Basic - optional annotation to indicate simple mapped attribute
- Maps any of the common simple Java types
  - Primitives, wrapper types, Date, Serializable, byte[ ], ...
- Used in conjunction with @Column
- Defaults to the type deemed most appropriate if no mapping annotation is present
- Can override any of the defaults

# Simple Mappings



# Simple Mappings


```
@Entity
public class Customer {
    @Id
    int id;
    @Column(length=50)
    String name;
    @Column(name="CREDIT")
    int c_rating;
    @Lob
    Image photo;
}
```

# Simple Mappings

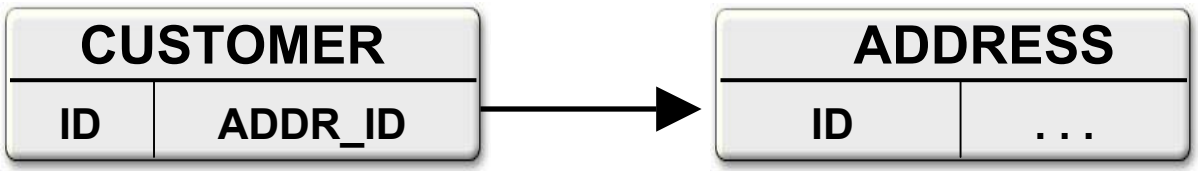
```
<entity class="com.acme.Customer">
    <attributes>
        <id name="id"/>
        <basic name="name">
            <column length="50"/>
        </basic>
        <basic name="c_rating">
            <column name="CREDIT"/>
        </basic>
        <basic name="photo">
            <lob/>
        </basic>
    </attributes>
</entity>
```

# Relationship Mappings

- **Common relationship mappings supported**
  - **@ManyToOne, @OneToOne - single entity**
  - **@OneToMany, @ManyToMany - collection of entities**
- **Unidirectional or bidirectional**
- **Owning and inverse sides of every bidirectional relationship**
- **Owning side specifies the physical mapping**
  - **@JoinColumn to specify foreign key column**
  - **@JoinTable decouples physical relationship mappings from entity tables**

# ManyToOne Mapping

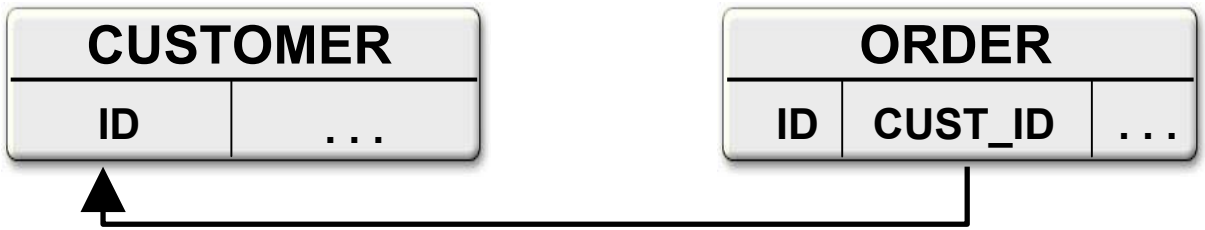
```
@Entity
public class Customer {
    @Id
    int id;
    @ManyToOne
    Address addr;
}
```



# OneToMany Mapping

```
@Entity
public class Customer {
   @Id
   int id;
   ...
   @OneToMany(mappedBy="cust")
   Set<Order> orders;
}
```

```
@Entity
public class Order {
   @Id
   int id;
   ...
   @ManyToOne
   Customer cust;
}
```



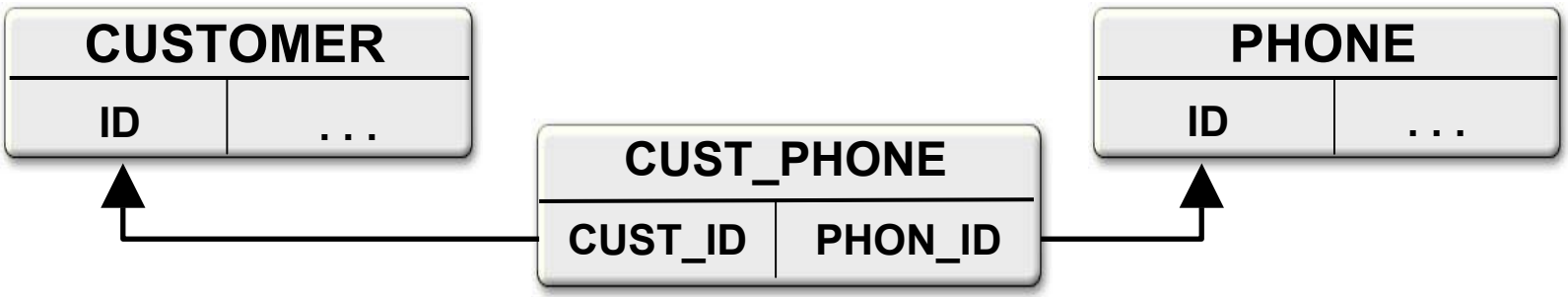
# ManyToMany Mapping

```
@Entity
public class Customer {
   @Id
   int id;
   ...
   @ManyToMany
   Collection<Phone> phones;
}
```

```
@Entity
public class Phone {
   @Id
   int id;
   ...
@ManyToMany(mappedBy="phones")
   Collection<Customer> custs;
}
```

# ManyToMany Mapping

```
@Entity
public class Customer {
  ...
  @ManyToMany
  @JoinTable(table="CUST_PHONE"),
    joinColumns=@JoinColumn(name="CUST_ID"),
    inverseJoinColumns=@JoinColumn(name="PHON_ID"))
  Collection<Phone> phones;
}
```



# Mapping of Embedded Objects

```
@Entity
public class Customer {
   @Id
   int id;
   @Embedded
   CustomerInfo info;
}
```

```
@Embeddable
public class CustomerInfo {
   String name;
   int credit;
   Image photo;
}
```

| CUSTOMER | | | |
|---|---|---|---|
| ID | NAME | CREDIT | PHOTO |

# Inheritance

- **Entities can extend**
  - **Other entities — concrete or abstract**
  - **Non-entity classes — concrete or abstract**
- **Map inheritance hierarchies in three ways**
  1. **SINGLE_TABLE — all classes stored in the same table**
  2. **JOINED — Each class (concrete or abstract) stored in a separate table**
  3. **TABLE_PER_CLASS — Each concrete class stored in separate table (optional)**

# Object Model

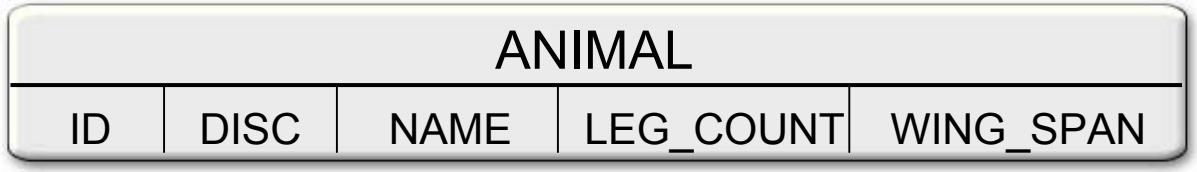
```
@Entity public abstract class Animal {
  @Id int id;
  String name;
}
```

```
@Entity public class LandAnimal extends Animal {
  int legCount;
}
```

```
@Entity public class AirAnimal extends Animal {
  short wingSpan;
}
```

# Data Models

**Single table:**




**Joined:**

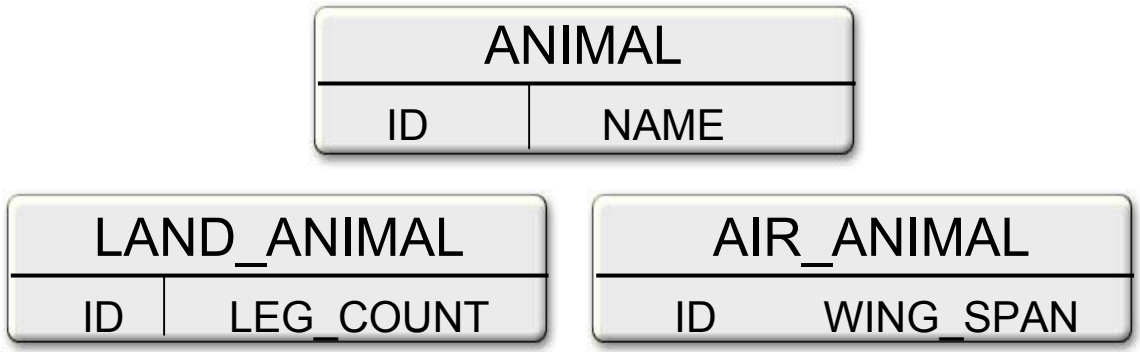
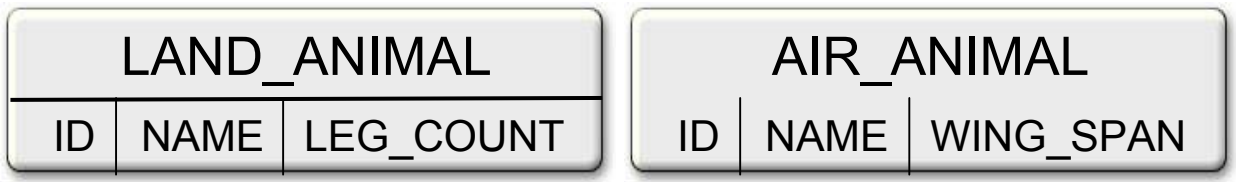



**Table per Class:**



# Persistence in Java SE

- No deployment phase
  - Application must use a “Bootstrap API” to obtain an EntityManagerFactory
- Typically use resource-local EntityManagers
  - Application uses a local EntityTransaction obtained from the EntityManager
- New persistence context for each and every EntityManager that is created
  - No propagation of persistence contexts

# Entity Transactions

- Resource-level transaction akin to a JDBC transaction
  - Isolated from transactions in other EntityManagers
- Transaction demarcation under explicit application control using EntityTransaction API
  - begin(), commit(), setRollbackOnly(), rollback(), isActive()
- Underlying (JDBC) resources allocated by EntityManager as required

# Bootstrap Classes

## `javax.persistence.Persistence`

- Root class for bootstrapping an EntityManager
- Locates a provider service for a named persistence unit
- Invokes on the provider to obtain an EntityManagerFactory

## `javax.persistence.EntityManagerFactory`

- Creates EntityManagers for a named persistence unit or configuration

# Example

```
public class SalaryChanger {
  public static void main(String[] args) {
    EntityManagerFactory emf = Persistence
        .createEntityManagerFactory("HRSystem");
    EntityManager em = emf.createEntityManager();
    em.getTransaction().begin();
    Employee emp = em.find(
        Employee.class, new Integer(args[0]));
    emp.setSalary(new Integer(args[1]));
    em.getTransaction().commit();
    em.close();
    emf.close();
  }
}
```

# Summary

- Entities are simple Java classes
  - Easy to develop and intuitive to use
  - Can be moved to other server and client tiers
- EntityManager
  - Simple and elegant API for operating on entities
  - Supports use inside and outside Java EE containers
- Standardization
  - O/R mapping using annotations or XML
  - Named and dynamic query definition using Java Persistence QL
  - SPI for pluggable Persistence Providers

# Links

- **Java Persistence API Reference Implementation (RI)**
  - **Oracle TopLink Essentials**
  - **Part of Sun Glassfish open source project**

    **http://glassfish.dev.java.net/**

- **EJB 3.0 Proposed Final Draft**

  **http://jcp.org/en/jsr/detail?id=220**

  Final draft to be released with Java EE 5

# Questions